Data Collection Activity - The Ring of Fire!

Introduction: The purpose of this activity is to model the flight of a ball that is launched at a specific angle. We will predict (graphically) the maximum height of the ball and also predict (both graphically and algebraically) where the ball will land when launched at this angle.

Your group's angle will be: __________ degrees.

I Basic Equations

As discussed in class, when a ball is thrown (or launched) at an angle θ from an initial height of s_0 ft with an initial velocity of v_0 ft/sec, the motion of the ball can be modeled by the parametric equations:

x = ____________________________ and **y** = ____

II. Collecting the Data

Using the projectile launcher, we need to measure two pieces of data. (Everything else can be calculated!)

1. The initial position/height s_0 of the ball when it is launched.

   s_0 = ____________________ in = _________________ ft

2. The horizontal distance **d** that the ball travels when it is launched horizontally ($\theta = 0°$) off the table.

   d = ____________________ in = ____________________ ft

III. Calculating the Initial Velocity

The first major value we need to calculate is the initial velocity (v_0) of the ball when it is launched. To calculate this we first need to find how long the ball was in the air when it is launched from an angle of 0°.

Substitute a 0° angle and the value s_0 that we measured into the parametric equations and then simplify both equations.

x = ______________________________________ = ______________________________________

y = ______________________________________ = ______________________________________

Knowing that the height (vertical position) of the ball is zero when it hits the ground, substitute **0** for **y** in your "y-equation" above and then solve it for **t**. (The variable **t** should be your only unknown in that equation!) Show your work below.

We don't want to "round-off" too much, so record the time it takes for the ball to hit the ground accurate to 3 decimal places.

t = ____________________ sec

Now substitute this value for **t** and the value for **d** that was previously measured into your "x-equation" and solve for v_0.

v_0 = ________________ ft/sec

IV. Viewing the Flight of the Ball

We now have enough information to build our parametric equations and graph them to see the flight of the ball after it is launched.

To review the information we have (and need):

s_0 = __________ ft, v_0 = ___________ ft/sec , and your group's angle θ = _________

Write the **parametric equations** that will model the flight of the ball when launched at this angle. Evaluate the cosine and sine of your angle θ and simplify each equation, again keeping 3 decimal places for each number.

x = ____

y = ____

Graph these parametric equations on your calculator. Show your graph below and state the window that you used to see the complete graph.

Tmin = __________ **Tmax** = __________

Xmin = __________ **Xmax** = __________

Ymin = __________ **Ymax** = __________

V. Predicting the Maximum Height of the Ball in Flight.

We are going to find the maximum height of the ball graphically.

TRACE on your graph to the point where the ball appears to be at it's maximum height. While tracing, you may need to enter values for **t** to get a very accurate value for the maximum height and the corresponding horizontal distance when it reaches it's maximum height..

Complete the statement: At an angle of __________ degrees, the ball reaches a maximum height of ___________ ft = _____________ in. It occurs at a time of ___________ secs, and at a distance ____________ ft = _____________ in horizontally from the launcher.

VI. Calculating the Horizontal Distance that the Ball Will Travel

Next, we are going to find the horizontal distance that the ball traveled both **graphically** and **algebraically**.

1. Graphically (This is easy!)
TRACE on your graph to the point where the ball hits the ground. Again, while tracing, you may need to enter values for **t** to get a very accurate value for the horizontal distance that the ball has traveled.
(Hint: You need to find the value of **t** that makes the **y-value** <u>very close</u> to zero.)

Complete the statement: At an angle of _________ degrees, the ball hits the ground __________ ft = ___________ in horizontally from the launcher after ___________ secs.

Now, let's see if we can find these same values **algebraically**.

2. Algebraically (This is harder!)
To find the distance that the ball travels, again we need to first find the time it takes for the ball to hit the ground. As before, set y = 0 in your "y-equation" above. This gives you the following **quadratic equation**:

0 = ________ t^2 + ____________________ **t** + ____________________.

This equation can be solved using the **Quadratic Formula** with:

a = ____________ , **b =** ___________________ , and **c =** ____________________

Put these values into the **Quadratic Formula** and then solve for **t**. Show your work below.

Results from the **Quadratic Formula**: **t =** ___________ and **t =** ___________

Only one of these values of **t** makes sense to the problem. Why?

____

Your "good" value for **t** should be <u>very close</u> to the value for **t** you obtained **graphically**. If not, find out why!

Substitute this value for **t** into your "x-equation" to find the horizontal distance that the ball will travel.

x = ___________________ ft.

I hope your calculations have been good, because we are going to test them with the projectile launcher next class!